

## PCT COOPERATION TRE Y

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner  
US Department of Commerce  
United States Patent and Trademark  
Office, PCT  
2011 South Clark Place Room  
CP2/5C24  
Arlington, VA 22202  
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 07 May 2001 (07.05.01)	
International application No. PCT/US00/23155	Applicant's or agent's file reference 99-2122/INT
International filing date (day/month/year) 23 August 2000 (23.08.00)	Priority date (day/month/year) 26 August 1999 (26.08.99)
Applicant XIE, Yuefeng	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:

27 February 2001 (27.02.01)

☐ in a notice effecting later election filed with the International Bureau on:2. The election ☒ was☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Juan Cruz Telephone No.: (41-22) 338.83.38
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## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US00/23155

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : B01D 24/02

US CL : 210/806, 807, 263, 290

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 210/806, 807, 263, 283, 284, 290, 500.1, 502.1, 503

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 4,172,031 A (HALL et al) 23 October 1979, col. 3, lines 48-50.	1, 5 and 15 ----- 2-4, 6-14 and 16-20
X --- Y	US 4,302,337 A (LARSON et al) 24 November 1981, col. 3, lines 47-49.	1, 5 and 15 ----- 2-4, 6-14 and 16-20
X --- Y	US 4,182,677 A (BOCARD et al) 08 January 1980, col. 2, line 51 and col. 4, lines 17-18.	1, 5 and 15 ----- 2-4, 16 and 17

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents:	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
*A* document defining the general state of the art which is not considered to be of particular relevance	*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
*E* earlier document published on or after the international filing date	*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*G* document member of the same patent family
*O* document referring to an oral disclosure, use, exhibition or other means	
*P* document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

12 NOVEMBER 2000

Date of mailing of the international search report

12 DEC 2000

Name and mailing address of the ISA/US  
Commissioner of Patents and Trademarks  
Box PCT  
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

IVARS CINTINS

Jean Proctor  
Patent Specialist

Telephone No. (703) 308-0651

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US00/23155

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,236,597 A (FEIST et al) 17 August 1993, entire document.	1-20

## PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTICE INFORMING THE APPLICANT OF THE  
COMMUNICATION OF THE INTERNATIONAL  
APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

To:

MONAHAN, Thomas, J.  
Intellectual Property Office  
The Pennsylvania State University  
113 Technology Center  
University Park, PA 16802-7000  
ETATS-UNIS D'AMERIQUE

Date of mailing (day/month/year) 01 March 2001 (01.03.01)		
Applicant's or agent's file reference 99-2122/INT Xie		IMPORTANT NOTICE
International application No. PCT/US00/23155	International filing date (day/month/year) 23 August 2000 (23.08.00)	
Priority date (day/month/year) 26 August 1999 (26.08.99)		
Applicant THE PENN STATE RESEARCH FOUNDATION et al		

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:

AU,KP,KR,US

In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:

AE,AG,AL,AM,AP,AT,AZ,BA,BB,BG,BR,BY,BZ,CA,CH,CN,CR,CU,CZ,DE,DK,DM,DZ,EA,EE,EP,ES,  
FI,GB,GD,GE,GH,GM,HR,HU,ID,IL,IN,IS,JP,KE,KG,KZ,LC,LK,LR,LS,LT,LU,LV,MA,MD,MG,MK,  
MN,MW,MX,MZ,NO,NZ,OA,PL,PT,RO,RU,SD,SE,SG,SI,SK,SL,TJ,TM,TR,TT,TZ,UA,UG,UZ,VN,YU,  
The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on  
01 March 2001 (01.03.01) under No. WO 01/14039

**REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)**

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a demand for international preliminary examination must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

**REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))**

If the applicant wishes to proceed with the international application in the national phase, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer  J. Zahra
Facsimile No. (41-22) 740.14.35	Telephone No. (41-22) 338.83.38

I Claim:**REPLACED BY  
ART 34 AMDT**

1. An improved filter comprising a filter having crumb rubber particles as a filter media.  
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2. The filter of claim 1, wherein said filter is a downflow granular filter.
3. The filter of claim 1, wherein said crumb rubber particles are 10-16 mesh size.  
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4. The filter of claim 1, wherein said crumb rubber particles are -10 mesh size.
5. The filter of claim 1, wherein said filter is a pilot filter.  
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6. The filter of claim 1, wherein said filter further includes a second filter media below said crumb rubber particles in said filter to act as a dual media filter.
7. The filter of claim 6, wherein said second filter media is sand.  
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8. The filter of claim 7, wherein said filter is a downflow granular filter.
9. The filter of claim 7, wherein said crumb rubber particles are 10-16 mesh size.  
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10. The filter of claim 7, wherein said crumb rubber particles are -10 mesh size.
11. The filter of claim 6, wherein said second filter media is anthracite.  
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12. The filter of claim 11, wherein said filter is a downflow granular filter.
13. The filter of claim 11, wherein said crumb rubber particles are 10-16 mesh size.

14. The filter of claim 11, wherein said crumb rubber particles are -10 mesh size.

5 15. A method of filtering a liquid comprising passing the liquid through a filter having crumb rubber particles as a filter media.

16. The method of claim 15, wherein the crumb rubber particles are 10-16 mesh size.

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17. The method of claim 15, wherein the crumb rubber particles are -10 mesh size.

18. The method of claim 15, wherein the filter further includes a second filter media below said crumb rubber particles in the filter to act as a dual media filter.

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19. The method of claim 18, wherein said second filter media is anthracite.

20. The filter of claim 18, wherein said filter is a downflow granular filter.

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# PATENT COOPERATION TREATY

RECEIVED

NOV 19 2001

From the  
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

**PCT**

## NOTIFICATION OF TRANSMITTAL OF INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

To: THOMAS J. MONAHAN  
INTELLECTUAL PROPERTY OFFICE  
THE PENNSYLVANIA STATE UNIVERSITY  
113 TECHNOLOGY CENTER  
UNIVERSITY PARK PA 16802-7000

Date of Mailing  
(day/month/year)

**13 NOV 2001**

Applicant's or agent's file reference

99-2122/INT

(Xie)

**IMPORTANT NOTIFICATION**

International application No.

PCT/US00/23155

International filing date (day/month/year)

23 AUGUST 2000

Priority Date (day/month/year)

26 AUGUST 1999

Applicant

THE PENN STATE RESEARCH FOUNDATION

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

### 4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices)(Article 39(1))(see also the reminder sent by the International Bureau with Form PCT/IB 301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/US

Commissioner of Patents and Trademarks  
Box PCT  
Washington, D.C. 20231

Authorized officer

IVARS CINTINS



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## PCT

WIPO

PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

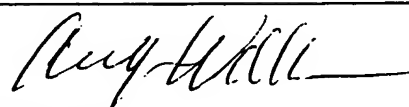
(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 99-2122/INT	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/US00/23155	International filing date (day/month/year) 23 AUGUST 2000	Priority date (day/month/year) 26 AUGUST 1999
International Patent Classification (IPC) or national classification and IPC IPC(7): B01D 24/02 and US Cl.: 210/806, 807, 263, 290		
Applicant THE PENN STATE RESEARCH FOUNDATION		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 4 sheets.
- ☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority. (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).
- These annexes consist of a total of 2 sheets.

## 3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of report with regard to novelty, inventive step or industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 27 FEBRUARY 2001	Date of completion of this report 23 SEPTEMBER 2001
Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Authorized officer IVARS CINTINS 
Facsimile No. (703) 305-3230	Telephone No. (703) 308-0651



## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US00/23155

## I. Basis of the report

## 1. With regard to the elements of the international application: \*

☐ the international application as originally filed☒ the description:

pages (See Attached) \_\_\_\_\_, as originally filed  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

☒ the claims:

pages (See Attached) \_\_\_\_\_, as originally filed  
pages \_\_\_\_\_, as amended (together with any statement) under Article 19  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

☒ the drawings:

pages (See Attached) \_\_\_\_\_, as originally filed  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

☒ the sequence listing part of the description:

pages (See Attached) \_\_\_\_\_, as originally filed  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language \_\_\_\_\_ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).☐ the language of publication of the international application (under Rule 48.3(b)).☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:☐ contained in the international application in printed form.☐ filed together with the international application in computer readable form.☐ furnished subsequently to this Authority in written form.☐ furnished subsequently to this Authority in computer readable form.☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.4. ☒ The amendments have resulted in the cancellation of:☒ the description, pages NONE☒ the claims, Nos. NONE☒ the drawings, sheets/fig NONE5. ☐ This report has been drawn as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).\*\*

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

\*\*Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US00/23155

## V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

### 1. statement

Novelty (N)

Claims 1-20

YES

Claims NONE

NO

Inventive Step (IS)

Claims 1-20

YES

Claims NONE

NO

Industrial Applicability (IA)

Claims 1-20

YES

Claims NONE

NO

### 2. citations and explanations (Rule 70.7)

Claims 1-20 meet the criteria set out in PCT Articles 33(2)-(3), because the prior art does not teach or fairly suggest a downflow filter having crumb rubber particles as a filter media, wherein the crumb rubber particles are compressible and wherein porosity between the crumb rubber particles decreases from the top to the bottom of the filter due to pressure on each of the crumb rubber particles.

Claims 1-20 have industrial applicability as defined by PCT Article 33(4) because the subject matter claimed can be made or used in industry.

\_\_\_\_ NEW CITATIONS \_\_\_\_  
NONE

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US00/23155

**Supplemental Box**

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Boxes I - VIII

Sheet 10

**I. BASIS OF REPORT:**

This report has been drawn on the basis of the description,  
page(s) 1-6, as originally filed.  
page(s) NONE, filed with the demand.  
and additional amendments:  
NONE

This report has been drawn on the basis of the claims,  
page(s) NONE, as originally filed.  
page(s) NONE, as amended under Article 19.  
page(s) NONE, filed with the demand.  
and additional amendments:  
Pages 7 and 8, filed with the letter of 14 August 2001.

This report has been drawn on the basis of the drawings,  
page(s) 1-5, as originally filed.  
page(s) NONE, filed with the demand.  
and additional amendments:  
NONE

This report has been drawn on the basis of the sequence listing part of the description:  
page(s) NONE, as originally filed.  
pages(s) NONE, filed with the demand.  
and additional amendments:  
NONE

anthracite filters in several ways. The crumb rubber media is compressible which allows the porosity between rubber particles to decrease through the filter bed. The crumb rubber media compresses as headloss increases, allowing for better effluent quality late in the run. The crumb rubber media allows greater depth filtration. The crumb rubber media can be used at high filter rates, greater than 20 gpm/ft<sup>2</sup>. The crumb rubber media performs similarly to other traditional filter media in respect to turbidity and total suspended solids removal. The crumb rubber media properties are closely tied to media size and shape, with smaller media providing better effluent qualities and larger media allowing longer filter runs at higher flow rates.

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In comparison to sand or anthracite, the crumb rubber is not a rigid material, instead it can easily be bent or compressed. The compressible of the crumb rubber media reduces the problem associated with conventional media dramatically by creating the inverse of this porosity gradient. The amount of compression increases with pressure, therefore compression increases and porosity decreases from the top to the bottom of the filter bed, as shown in Fig. 2. This allows the larger solids to be removed in the top layer of the filter and the smaller solids removed in the bottom layer. Therefore, crumb rubber media allows greater depth filtration, lower head loss, and longer filter runs. Another advantage crumb rubber has over conventional media is that its surface is not smooth. Crumb rubber is rough with some small hairs protruding from its sides. In contrast, anthracite has very smooth sides. The roughness gives crumb rubber more surface area to capture solid particles, allowing each particle to intercept more solids.

Two pilot filters were constructed to compare the crumb rubber media to the conventionally used media. Each filter column measured ten feet in height and four inches in diameter. The conventional media used was a dual media of sand and anthracite. Each filter contained 12 inches of support media and 36 inches of filter media, measured on a dry basis. A constant head was kept above the top of the filter bed by use of an overflow 9 feet above the top of the support media, leaving 6 feet above the initial 3 feet of media height. Static head was measured every six inches through the filter bed and flow was controlled by a globe valve and a rotameter on the filter outlet.

The dual media depth was 24 inches of anthracite over 12 inches of sand, which was chosen to simulate conditions at wastewater treatment plants. The depth of the